Research Newsletter

Responsive - Accessible - Relevant

A MESSAGE FROM THE RESEARCH DIRECTOR

By: Cameron Kergaye, PhD, PMP, PE

The next UDOT research workshop (UTRAC) will take place April 8. This is our primary workshop for identifying solutions to our transportation challenges. Last year 52 problem statements were submitted from engineers and academia covering six subject areas. We expect the same or greater number this year as we make changes to a couple subject areas and add a seventh: Transportation Innovation. This new subject area will focus on innovative construction techniques and solutions. Most of the participants in this group are expected to have a background in construction or experience with unique construction projects nationally.

Three research projects from UDOT over the last year are also receiving national attention by AASHTO. These recently completed studies have been nominated as High Value Research, a distinction conferred to research that demonstrates measurable value and usefulness to transportation agencies:

- Raised Median Economic Impact Study
- Identifying a Profile for Non-Traditional Cycle Commuters
- Identifying Characteristics of High-Risk Intersections for Pedestrians and Cyclists

Other good transportation related news comes from TRB funding for several NCHRP research problem statements submitted by UDOT last fall. The just-published list includes 4 problems either co-developed or co-submitted by UDOT, which generally means national funding to consider research directly related to our local needs. The final vote of the states will take place in June.

2013 TRB Annual Meeting

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Completed and Active Research Available at: www.udot.utah.gov/go/research

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By: Steven Bartlett, Ph.D.
University of Utah
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Geofoam Embankments: Design & Evaluation for the I-15 Reconstruction in Salt Lake County

Starting about 15 few years ago, several researchers were involved in a series of I-15 National Test Bed studies led by UDOT during the I-15 Reconstruction Project in Salt Lake County. The research scope for the University of Utah team focused mainly on performance of large embankments paired with innovative soil foundation treatments. Expanded Polystyrene (EPS) geofoam block was placed at various locations on the project to minimize post-construction settlement of deep, compressible lake deposits. Geofoam embankments had the best overall settlement performance of the geotechnologies monitored. Use of geofoam on the I-15 project paved the way for additional use by other transportation agencies. Following is a summary of the design and long-term performance evaluation of the I-15 geofoam embankments.

Typical geofoam embankment construction on the I-15 Reconstruction Project

The I-15 Reconstruction Project geofoam embankments were designed using the draft European Standard of 1998. To limit long-term creep deformation of the geofoam block to non-damaging levels, the working stress level due to dead load was limited to 30 percent of the compressive resistance for Type VIII geofoam. Also, an additional 10 percent of the compressive resistance was allowed to account for live traffic loads; hence the total load combination of dead and live load could not exceed 40 percent of the compressive resistance at 10 percent axial strain, or about 40 kilopascals (840 lbs/ft^2).

The completed 10-year post-construction settlement monitoring shows that the I-15 geofoam embankments are performing as designed, thus validating the 1998 European Standards. These standards were updated in 2011 and are recommended by the researchers for use in combination with methods in NCHRP Report 529. Long-term field measurements from the I-15 Reconstruction Project show that the creep settlement will not exceed the 50-year post-construction deformation limit of 1 percent creep strain. Experience has shown that extra care is required when placing earthen fill in areas of geofoam placement, otherwise additional post-construction settlement of the geofoam embankment can be expected.

Numerical modeling was also used to estimate the complex stress distribution and the displacements (i.e. strain) that developed in some of the geofoam embankments. The proposed numerical approach used a bilinear elastic model to produce reasonable estimates of gap closure, block seating, and the subsequent elastic compression of the geofoam embankment at higher stress levels. Such estimations are important for modeling and designing geofoam embankments and potential connections with other systems.

EPS geofoam can also be used to construct earthquake resilient infrastructure in areas with high seismicity because of its extremely low mass density and relatively high compressibility when compared with traditional backfill materials. The researchers recommend structural/mechanical restraints for free-standing EPS embankment systems where the seismically-induced sliding displacement is potentially damaging to the geosystem.

For more details see the final report on the Research Division website, or contact Dr. Steven Bartlett of the University of Utah at bartlett@civil.utah.edu, or the following UDOT study participants: Jon Bischoff (jonbischoff@utah.gov) and David Stevens (davidstevens@utah.gov).

By: Charles Allen
InterPlan Co
Cameron Kergaye, P.E., Ph.D.
UDOT Research Division

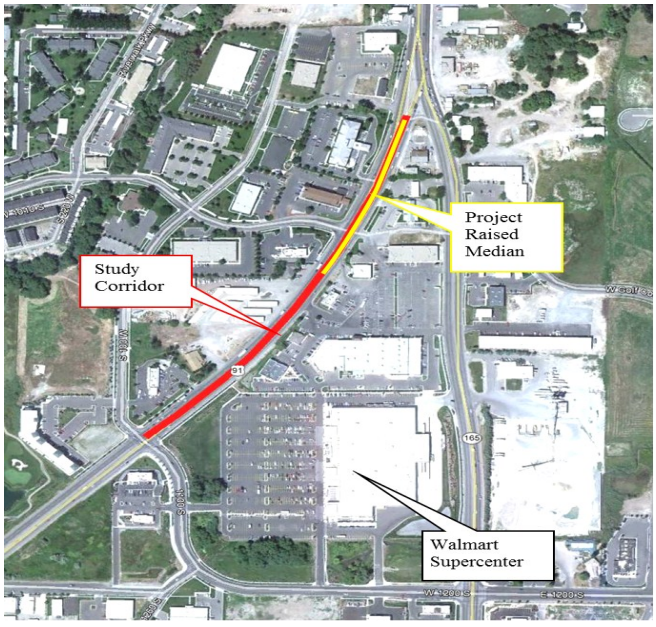
Raised Median And Economic Impact Study

While raised medians projects have a well-documented track record of improving roadway safety and capacity, the economic impacts to adjacent businesses are less clear. Individual business owners often oppose raised median projects due to a fear of business loss. A better understanding of the economic effects of raised median projects will aid in UDOT's communication with local business owners and help UDOT to fulfill its strategic goal to *Strengthen the Economy*.

The goal of this study was to examine the business patterns on roadway corridors where recent raised median projects occurred. A secondary goal was to compare the opinions and attitudes of the individual business owners on the corridors.

InterPlan Co and GSBS Richman performed a retail sales tax analysis on three corridors with a raised median project and three corridors with a comparable construction project that did not implement a raised median. InterPlan also conducted door-to-door surveys among the businesses on these corridors.

Using aggregated sales tax data supplied by the Utah State Tax Commission, InterPlan and GSBS Richman measured the sales patterns before and after project completion. Overall retail square footage provided a benchmark to account for changes in land use during these projects. InterPlan's survey elicited feedback regarding perceived business loss, business access, and roadway safety.



Study Corridor in Logan

The sales tax data showed that there was no evidence of a negative impact on corridor retail sales due to the installation of a raised median. In all cases, corridor-area retail sales and sales per square foot increased after the raised median was installed. Individual business-owner attitudes differed, however, with many owners reporting negative perceptions of sales impacts.

Locations of Study Corridors

Area	Type	Road & Route	Extents
Cache County	Study	Main St Logan, US-89/ US-91	100 W to 900 S
	Control	Main St Logan, US-91	1000 N to 1600 N
Salt Lake County	Study	State St, US-89	9000 S to 10000 S
	Control	Redwood Rd, SR-68	10400 S to 11400 S
Washington County	Study	State St, SR-9	300 W to 800 N
	Control	State St, SR-9	3700 W to 300 W

The study findings supply UDOT with locally-derived, raised median economic impact data that can aid UDOT in reaching out to businesses affected by future raised median projects. Further research may examine the long-term impacts on raised median corridors and examine the overall changes to retail mix in response to continued changes to roadway corridors.

For more details see the final report on the Research Division website, or contact Matt Riffkin of interPlan Co matt@interplanco.com, or Scott Jones, UDOT Traffic & Safety wsjones@utah.gov

By: Kyle Rollins, Ph.D.
Brigham Young University
David Stevens, P.E.
UDOT Research Division

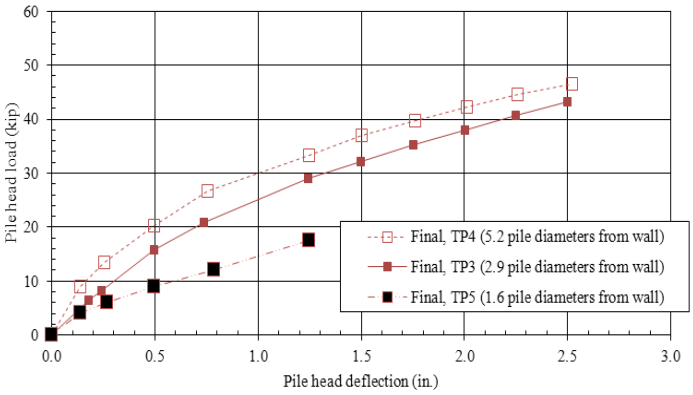
Lateral Resistance of Piles near Vertical MSE Abutment Walls

Pile foundations for bridges with integral abutments must resist lateral loads produced by earthquakes and thermal expansion or contraction. Increasingly, right-of-way constraints are also leading to vertical mechanically stabilized earth (MSE) walls at abutment faces. Currently, there is relatively little guidance for engineers in assessing the lateral resistance of piles located close to these MSE walls. The approach of designers to this aspect varies widely, and this can have significant effects on foundation cost as well as bridge span and cost. A research project was recently completed to help UDOT better understand and address this issue.

Using three active bridge construction sites on UDOT projects in Utah County, researchers from Brigham Young University performed full scale lateral load tests on eight piles located at various distances behind MSE walls. The objective of the testing was to determine the effect of spacing from the wall on the lateral resistance of the piles and on the force induced in the MSE reinforcement by the pile load. One test site is shown in the following figure.

Load test setup at the Pioneer Crossing site

Lateral load-displacement curves were obtained for the test piles at various spacing and with various reinforcement ratios (reinforcement length, L divided by wall height, H). As the pile spacing behind the MSE wall decreased, the lateral pile resistance decreased substantially similar to the following figure. However, by increasing the reinforcement length the reduction in lateral resistance was arrested to some degree.



Load-displacement curves for three piles of various spacing from the wall, Pioneer Crossing site

Lateral load analyses were performed using the LPILE program to determine the minimum spacing required to eliminate any effect of the wall on the pile resistance and the reduction in soil resistance as a function of normalized distance and reinforcement length. Little pile-wall interaction was observed for piles located more than 4 to 6 pile diameters behind the wall depending on the reinforcement. The induced force in the reinforcements increased as lateral load increased and decreased rapidly with transverse distance relative to the point of loading.

Tentative design curves have been developed based on the limited available testing to date. However, additional testing is necessary to define behavior for lower L/H ratios typical of static conditions and to refine relationships for determining p-multipliers and induced reinforcement forces. This additional testing is expected to be performed as part of an upcoming pooled-fund study with support from UDOT and at least six other state DOTs.

For more details see the final report on the Research Division website, or contact Dr. Kyle Rollins of BYU at rollinsk@byu.edu, or the following UDOT study participants: Jon Bischoff (jonbischoff@utah.gov) and David Stevens (davidstevens@utah.gov).

By: Shaunna K. Burbidge, Ph.D.
Active Planning
Kevin Nichol, P.E.
UDOT Research Division

Identifying a Profile for Non-Traditional Cycle Commuters

Cycling has frequently been advocated as an easy low cost form of physical activity that is accessible to most individuals, regardless of age or ability. Additionally, when used as a mode of transportation, cycling can lead to reductions in air pollution, carbon emissions, congestion, noise, and traffic dangers, not to mention saving users money in vehicle ownership and maintenance costs. A 2011 Dan Jones survey commissioned by UDOT revealed that 13% of Utahns commute by bicycle at least once per week. This was in stark contrast to census data that measured cycle commuting rates statewide at a mere 0.8% (Salt Lake City Metro Area = 0.6%; Provo-Orem Metro Area = 1.3% (U.S. Census, 2011)). These startling data provide compelling evidence regarding the importance of planning for cyclists as a major part of the transportation system. They also validate the idea that cycling impacts a larger segment of the population than just a small group of motivated recreationists or cycle advocates.

There are a number of benefits to cycling including improved personal health, environmental quality, economic vitality, etc. However there are also a large number of barriers to cycling for transportation. These barriers can be both physical as well as psycho-social or emotional. The way that individuals respond to these barriers ultimately determines how likely they are to cycle for transportation.

This research analyzes self-reported data collected as a part of the 2012 Utah Household Travel Survey to identify who these non-traditional cyclists are, their motivations for cycling, the purposes of their cycling trips, and what barriers keep them from cycling more often. Additionally, this research created a profile for these non-traditional cyclists.

Four types of cyclists were identified in this research using a classification scheme introduced in Portland by Geller (2012) as a base model, while a latent class cluster analysis was employed to identify significant demographic differences between cyclist types. "Strong and Fearless" cyclists (4%) are most likely lower income males who also exhibit higher rates of unemployment, while the "No Way No How" or non-cyclist cluster (54.3%) is primarily made up of women with lower levels of education and household income, who have small households with fewer children. The non-traditional cyclists, the target group for this research, are typically individuals with higher incomes and more education who have large families and a larger number of younger children. These individuals also report having access to an adequate number of bicycles.

An analysis of cycling trip purposes reveals that non-traditional cyclists are most likely to bike for exercise and to escort their children, while the "Strong and Fearless" cyclists are more likely to cycle for utilitarian/transportation purposes. These groups also exhibit different motivations for choosing to cycle. While both groups enjoy the exercise and being outside, "Strong and Fearless" cyclists were significantly more likely to report cycling to save money and to protect the environment.

For individuals who reported that they would "never bike" the major reasons included not owning a bike and being busy or viewing cycling as taking too long. For these individuals there is likely little that can be done to promote cycling as a transportation mode. Even providing every adult in the region with a working bicycle would not likely overcome these barriers considering that one in five respondents stated that they simply do not enjoy cycling.

Key conclusions of this research show that it is unrealistic to assume that individuals in the non-traditional cyclist group will give up their automobile and begin making a majority of their trips for all purposes via bicycle. However, it is incredibly realistic to assume that this group could be persuaded to occasionally leave a vehicle at home and make purpose specific trips by bicycle where appropriate. By focusing promotional materials to address issues that are meaningful to this group of individuals, a significant number of trips could be shifted from auto to non-motorized modes.

For more details see the final report on the Research Division website, or contact Dr. Shaunna K. Burbidge of Active Planning at burbidge@walkbikeplan.com, or Kevin Nichol of the UDOT Research Division at knichol@utah.gov .

By: W. Spencer Guthrie, Ph.D.
Brigham Young University
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Internal Curing of Concrete Bridge Decks in Utah: Preliminary Evaluation

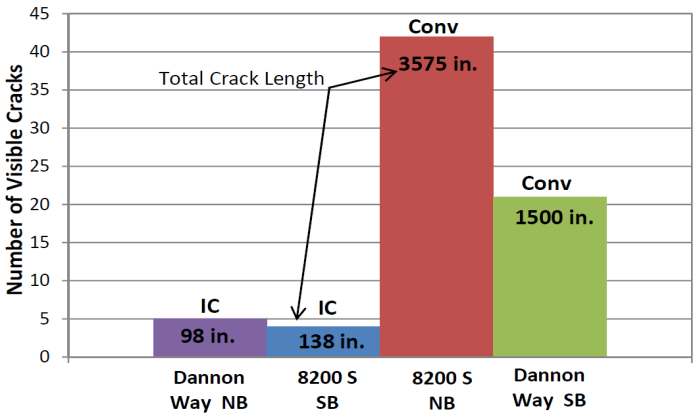
Internal curing of concrete bridge decks with pre-wetted lightweight fine aggregate (LWFA) has been used in a few states to extend deck service life by densifying the microstructure of concrete, reducing permeability, and reducing shrinkage cracking. In the spring of 2012, four new bridges were constructed in the West Jordan area on the Mountain View Corridor (MVC) Project, two at Dannon Way and two at 8200 South. At each location, one bridge deck was constructed using a conventional concrete mixture and one was constructed using a concrete mixture containing a portion of pre-wetted LWFA to facilitate internal curing. This is UDOT's first internal curing project.

Researchers at Brigham Young University are evaluating the performance of these decks with UDOT by 1) monitoring in-situ bridge deck properties such as moisture and diffusivity with sensors embedded in the decks, 2) comparing deck performance in terms of early-age cracking with distress surveys, and 3) evaluating the field-cast concrete mixtures in the laboratory in terms of compressive strength and chloride permeability.

Concrete placement around deck sensor

Results through the end of 2012 are encouraging. Moisture content of the internally cured concrete was consistently 2 to 3 percent higher than the moisture content of the conventional concrete. Electrical conductivity values, indicating diffusivity, were approximately the same for all the decks after a couple of months.

Regarding distress surveys, on average, at 5 and 8 months, *the conventional bridge decks had about 4 and 21 times as much cracking as the internally cured decks*, respectively. Cracks found on the internally cured bridge decks were mainly located at the ends of the decks, whereas cracks in the conventional concrete bridge decks were well distributed throughout both decks.



Distress data at 8 months post-construction

Laboratory compressive strength data indicate that, through 3 months, the two concrete mixtures exhibited very similar strength gain characteristics. At 6 months, the conventional concrete was stronger by an average of 12 percent than the internally cured concrete. The rapid chloride permeability test results show that the internally cured concrete passed between 2 and 30 percent and between 2 and 25 percent less current during the test than the conventional concrete at 28 days and 6 months, respectively. Both types of concrete can be classified as having low chloride permeability.

The research team plans to continue monitoring deck sensors into the spring of 2014 along with additional laboratory testing and data analysis. Additional crack surveys are also planned. Based on the improved performance observed early on the two internally cured decks, UDOT materials engineers plan to develop a specification for internally cured concrete for future projects. For more information contact Dr. Spencer Guthrie of BYU at guthrie@byu.edu or Joe Kammerer on the MVC Project at jkammerer@utah.gov.

By: Kevin Heaslip, Ph.D.
Utah State University
Cameron Kergaye, Ph.D.
UDOT Research Division

2012 UDOT Peer Exchange

Every five years, the Federal Highway Administration requires state DOT's to conduct a Peer Exchange to help improve the quality and efficacy of the State DOT's research management process. Outside research managers are invited to meet with the host agency to discuss and review its research management process and provide ideas in a specific focus area. During the peer exchange, panel members may meet with managers, staff, stakeholders, and customers to gain further insight into the host agency's program. In October of 2012, representatives from seven state DOT's (Idaho, Minnesota, Iowa, Oklahoma, Montana, South Dakota, and Wyoming, and four federal agencies (SHRP2, FHWA, RITA, and TRB) traveled to Salt Lake City to participate in the peer exchange. The themes of the peer exchange were research implementation and leadership involvement.

Over the course of three days, each participant was asked to provide examples of successful implementation of research and best practices in the engagement of leadership. The participants also had the opportunity to give presentations and participate in the UDOT Annual Conference.

UDOT research staff learned valuable lessons from successful research from each of the participants, examples of which are Living Snow Fences, implemented in Minnesota, to the Teen Safe Driver Program, implemented in Iowa, which has gained national recognition

Living Snow Fences in Minnesota

Screen Shot from the Iowa Safe Teen Driver study

and has been implemented by American Family Insurance.

There were many positive outcomes from the Research Peer Exchange, but the main lesson learned was that excellent communication by all those involved in research was vital to success. Communication between research and leadership is necessary to show the value of research and align research with the overarching goals of the department. Also, communication between the researchers, research section, and persons that will be implementing the research is necessary to align research conducted with the needs of the department and that will be implemented upon the conclusion of the research. The role of the project champion who is passionate, articulate and knowledgeable in the field was singled out as a key. The research peer exchange provides a building block for the foundation of success that UDOT Research has worked hard to build over the years.

For more details, contact Dr. Kevin Heaslip of Utah State University at kevin.heaslip@usu.edu , or Cameron Kergaye of the UDOT Research Division at ckergaye@utah.gov

By: Steve Bagley, MPC
UDOT Research Division

RESEARCH CALENDAR OF EVENTS

2013 UDOT RESEARCH WORKSHOP (UTRAC)

APRIL 8, 2013 - UDOT Research Division is pleased to host another research workshop (UTRAC) to identify solutions to our transportation challenges. For more information about the 2013 Research Workshop please click the image link:

FUNDING OPPORTUNITIES

Month	Topic	Due Date
April	NCHRP Project 20-7 Spring Submission Cycle Proposals (Submitted by AASHTO CommitteesReporting to the Standing Committee on Highways) Montana DOT Research Topic Statements	April 15, 2013 April 30, 2013
May	Transit IDEA Proposals	May 1, 2013
June	TCRP FY 2014 Problem Statements	June 15, 2013
July	N/A	N/A

UPCOMING WEBINARS

(For more information, contact Joni DeMille: jdmille@utah.gov)

Title	Day/Date	Time
Guidelines for the Use of Mobile LIDAR in Transportation Applications (TRB)	Thursday, April 11	11:00 AM – 12:30 PM
Reward & Recognition on a Limited Budget *(on demand)*	Tuesday, April 16	11:00 AM – 12:00 PM
50 Ways to Lose Your Money!! (NHI)	Wednesday, April 17	11:00 AM – 1:00 PM
Promising Practices for Concrete Paving for Young Engineers (TRB)	Tuesday, April 30	12:00 PM – 2:00 PM
Tribal Transportation Program Safety Funding (NHI)	Wednesday, May 1	11:00 AM – 12:30 PM
Why Teams Fail—Dealing with Friction & Dissension *(on demand)*	Thursday, May 2	11:00 AM – 12:00 PM